Changing Segregation Patterns by Age Group in the Tokyo Metropolitan Area

— From the Viewpoint of Migration with Cohort Analysis —

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Abstract

The purpose of this study is to describe the residential segregation patterns by 5-year age group and their recent changes in the Tokyo metropolitan area, and to explain the effects of migration on the segregation pattern. This study adopted the viewpoint of cohorts, and yielded the following results:

First, most of the segregation patterns of 14 age groups show a concentric tendency; the age groups 0–14 and 30–44 tend to be distributed more densely in the outer part of the metropolitan area (Outer Tokyo), and the age groups 15–29 and 45 and over tend to be distributed more densely in the inner part of the metropolitan area (Inner Tokyo). However, in the period between 1980 and 1985 the age groups 15–19 and 45–49 shifted their distributions from Inner Tokyo to Outer Tokyo, and the age group 30–34 shifted from Outer Tokyo to Inner Tokyo.

Second, two main migration flows are observed: the migration of the young from outside of the metropolitan area to Inner Tokyo, and the migration of young families from Inner Tokyo to Outer Tokyo. These two migration flows have effects on creating the principal age segregation patterns.

Third, with applied cohort analysis, an increase of the young who were born and brought up in the Tokyo metropolitan area, “the Native Young”, was observed, as well as a decrease of the young who immigrate into the metropolitan area from the outside, “the Foreign Young”.

Fourth, the recent change of the segregation pattern of the 15–19 age group after 1980 is caused not only by the recent decrease of “the Foreign Young”, but also by the increase of “the Native Young” who moved to Outer Tokyo with their parents in the past.

Fifth, the age segregation in the Tokyo metropolitan area will be probably weakened by the maturity of the suburbs in the next decades.

Key words: Tokyo metropolitan area, age segregation, migration, cohort analysis

I. INTRODUCTION

1. Factorial ecology and residential mobility studies

Studies of factorial ecology here provided the yardstick for description and comparison of urban structures; many Japanese geographers have adopted this method and compared the urban structures of Japanese cities¹⁾ with those of Western cities. According to these studies, the two main factors of Japanese cities are family status and socio-economic status: the spatial pattern of family status is zonal and that of socio-

economic status is sectoral, as in the case of Western cities. However, these studies also show that family status is the first component and socio-economic status is the second component in Japanese cities, which is the reverse of the situation in Western cities. Family status is accordingly a very important factor for Japanese cities in differentiating residential areas, as socio-economic status is for Western cities. Age is one of the principal indices of family status, hence the author selected the segregation pattern by age group as the subject of this study.

While factorial ecology gives valuable guidelines for describing static residential structure, it gives only limited intimations of how ecologi-

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cal patterns are created and maintained, as SHORT (1978) suggests. Moreover, "the movement of households from one residence to another is widely accepted to play an important part in shaping and reshaping urban residential structure" (KNOX, 1982), and many geographers have taken interest in studies of residential mobility since about 1970.

There have recently been a great number of papers which discuss various aspects of this movement, and several reviews about these papers (for example, QUIGLEY and WEINBURG, 1977; SHORT, 1978; BASSETT and SHORT, 1980; CLARK, 1981). The 1970's was also the period of the behavioral approach in geography: thus, many studies on residential mobility were made from this viewpoint, and the individual level was often adopted as the scale of analysis. As a result, there is now a lot of information about the individual decision-making process. However, the more strongly these studies concern individual behavior, the weaker their concern with urban residential structure becomes. MAHER asserts in his paper (1982), that his study is concerned less with the traditional focus of intraurban mobility studies in explaining individual behavior than it is with the manner in which mobility can result in an altered social, economic and demographic environment. Thus, we have only insufficient information on how residential mobility effects the change of residential structure.

Consequently, the purpose of this paper is to describe the residential segregation pattern by age group and its recent changes in the Tokyo metropolitan area, and then to explain the effect of migration on forming and altering this pattern.

2. Study area and study period

The study area (Tokyo metropolitan area) is selected on the basis of the 1980 Population Census of Japan (Fig. 1). This area consists of a central city and surrounding areas. The central city corresponds to the ward area, which consists of 23 municipalities (Wards or *Ku*) in central Tokyo; while the surrounding area consists of 131 suburban municipalities²⁾. Thus, the Tokyo metropolitan area discussed in this paper consists of 154 municipalities, which are adopted as basic analytical units.

All data are from the Population Censuses of Japan for 1960, 1965, 1970, 1975, 1980 and 1985³⁾. TANABE (1988) indicates the existence of three stages of Tokyo's urban growth, the period of Edo, the first half of the 20th century and the period of rapid economic growth after the Second World War, especially after about 1960. Moreover, he distinguishes three concentric zones in the Tokyo metropolitan area: an old zone, new zone and extended zone, which correspond to his three stages. He asserts that it was after about 1960 that Tokyo entered into the process of metropolitanization. I discuss accordingly the period after 1960.

II. RESIDENTIAL SEGREGATION BY AGE GROUP

1. Segregation analysis at municipality level

This section aims at showing the age segregation pattern at municipality level in the Tokyo metropolitan area. Fourteen five-year age groups (0-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65 and over) are adopted here, for which there are two reasons. First, previous studies adopted larger age groups, but closer consideration is necessary. Second, I intend to make a cohort analysis in Chapter III by using the census data for every five years.

Segregation is defined as follows: "the residential separation of subgroups within a wider population. A group is completely unsegregated when its members are distributed uniformly relative to the remainder of the population" (*The dictionary of human geography*, 1986). Residents of each age group are not always distributed uniformly in relation to the total population in the Tokyo metropolitan area, and here I would like to call such unequal distribution residential segregation by age group.

The method of describing the age segregation pattern is as follows: 1) Calculating the ratio of one age group population to the total population in every municipality; 2) Mapping the results; 3) Repeating this procedure for all 14 five-year age groups and for all six years of census (1960, 1965, 1970, 1975, 1980, 1985).

As a result, 84 maps have been obtained which

Figure 1. Study area and two concentric zones

1. Koga-shi	2. Ryugasaki-shi	3. Toride-shi	4. Ushiku-machi	5. Kukizaki-machi
6. Ina-machi	7. Moriya-machi	8. Fujishiro-machi	9. Tone-machi	10. Nogi-machi
11. Kawagoe-shi	12. Kawaguchi-shi	13. Urawa-shi	14. Omiya-shi	15. Tokorozawa-shi
16. Iwatsuki-shi	17. Kasukabe-shi	18. Sayama-shi	19. Konosu-shi	20. Ageo-shi
21. Yono-shi	22. Soka-shi	23. Koshigaya-shi	24. Warabi-shi	25. Toda-shi
26. Iruma-shi	27. Hatogaya-shi	28. Asaka-shi	29. Shiki-shi	30. Wako-shi
31. Niiza-shi	32. Okegawa-shi	33. Kuki-shi	34. Kitamoto-shi	35. Yashio-shi
36. Fujimi-shi	37. Kamifukuoka-shi	38. Misato-shi	39. Hasuda-shi	40. Sakado-shi
41. Ina-machi	42. Fukiage-machi	43. Oi-machi	44. Miyoshi-machi	45. Moroyama-machi
46. Tsurugashima-machi	47. Hidaka-machi	48. Hatoyama-machi	49. Kitakawabe-machi	50. Otone-machi
51. Miyashiro-machi	52. Shiraoka-machi	53. Kurihashi-machi	54. Washinomiya-machi	55. Satte-machi
56. Sugito-machi	57. Matsubushi-machi	58. Yoshikawa-machi	59. Showa-machi	60. Chiba-shi
61. Ichikawa-shi	62. Funabashi-shi	63. Matsudo-shi	64. Noda-shi	65. Sakura-shi
66. Narashino-shi	67. Kashiwa-shi	68. Nagareyama-shi	69. Yachiyo-shi	70. Abiko-shi
71. Kamagaya-shi	72. Urayasu-shi	73. Shonan-machi	74. Yotsukaido-shi	75. Shisui-machi
76. Shiroti-machi	77. Chiyoda-ku	78. Chuo-ku	79. Minato-ku	80. Shinjuku-ku
81. Bunkyo-ku	82. Taito-ku	83. Sumida-ku	84. Koto-ku	85. Shinagawa-ku
86. Meguro-ku	87. Ota-ku	88. Setagaya-ku	89. Shibuya-ku	90. Nakano-ku
91. Suginami-ku	92. Toshima-ku	93. Kita-ku	94. Arakawa-ku	95. Itabashi-ku
96. Nerima-ku	97. Adachi-ku	98. Katsushika-ku	99. Edogawa-ku	100. Hachioji-shi
101. Tachikawa-shi	102. Musashino-shi	103. Mitaka-shi	104. Fuchu-shi	105. Akishima-shi
106. Chofu-shi	107. Machida-shi	108. Koganei-shi	109. Kodaira-shi	110. Hino-shi
111. Higashimurayama-shi	112. Kokubunji-shi	113. Kunitachi-shi	114. Tanashi-shi	115. Hoya-shi
116. Fussa-shi	117. Komae-shi	118. Higashiyamato-shi	119. Kiyose-shi	120. Higashikurume-shi
121. Musashimurayama-shi	122. Tama-shi	123. Inagi-shi	124. Tsurumi-ku	125. Kanagawa-ku
126. Nishi-ku	127. Naka-ku	128. Minami-ku	129. Hodogaya-ku	130. Isogo-ku
131. Kanazawa-ku	132. Kohoku-ku	133. Totsuka-ku	134. Konan-ku	135. Asahi-ku
136. Midori-ku	137. Seya-ku	138. Kawasaki-ku	139. Saiwai-ku	140. Nakahara-ku
141. Takatsu-ku	142. Tama-ku	143. Miyamae-ku	144. Aso-ku	145. Kamakura-shi
146. Fujisawa-shi	147. Chigasaki-shi	148. Zushi-shi	149. Sagami-hara-shi	150. Yamato-shi
151. Ebina-shi	152. Zama-shi	153. Ayase-shi	154. Hayama-machi	

Figure 2. Segregation pattern of the 15-19 age group (1975)

1: over $\bar{x} + \sqrt{v}$
 2: $\bar{x}$ to $\bar{x} + \sqrt{v}$
 3: $\bar{x} - \sqrt{v}$ to $\bar{x}$
 4: under $\bar{x} - \sqrt{v}$
 $\bar{x}$ (mean) = 6.44%; $\sqrt{v}$ (standard deviation) = 0.88
 Source: Population Census of Japan 1975

Figure 3. Segregation pattern of the 15-19 age group (1985)

1: over $\bar{x} + \sqrt{v}$
 2: $\bar{x}$ to $\bar{x} + \sqrt{v}$
 3: $\bar{x} - \sqrt{v}$ to $\bar{x}$
 4: under $\bar{x} - \sqrt{v}$
 $\bar{x}$ (mean) = 8.18%; $\sqrt{v}$ (standard deviation) = 0.78
 Source: Population Census of Japan 1985

illustrate the residential segregation pattern by age group at municipality level. Fig. 2 and Fig. 3 are examples of these 84 segregation maps. Fig. 2 shows that the 15-19 age group was distributed more densely in the central part of the metropolitan area than in the suburbs in 1975. On the other hand, one notices in Fig. 3 that the segregation pattern of the same age group in 1985 is the reverse of that 10 years before. These two maps will be discussed again in Chapter III. Most of the 84 residential segregation maps have a concentric pattern, as the previous factorial ecology studies showed, and these concentric patterns can be broken down into two groups, distributed more densely in the center and more densely in the suburbs.

2. Segregation analysis by two concentric zones

The aim of this section is to simplify the 84 segregation maps. According to the above two findings, municipalities in the Tokyo metropolitan area are classified into five concentric zonal areas by distance from the center⁴⁾, i.e. 0-10km, 10-20km, 20-30km, 30-40km, 40km and over. Having considered segregation patterns at this concentric zone level, I have found that the characteristics of the age segregation patterns are demonstrated most clearly,

Figure 4. Population change of the Tokyo metropolitan area

Source: Population Census of Japan 1960-1985

when the five concentric zonal areas are geared to two areas: one up to 20km from the center, the other over 20km. I would like to call these two areas "Inner Tokyo" and "Outer Tokyo". Inner Tokyo consists of the ward area of Tokyo and 21 municipalities in the surrounding area, and Outer Tokyo consists of the remaining 110 municipalities of the Tokyo metropolitan area (see Fig. 1).

As shown in Fig. 4, the population in Inner Tokyo has not increased remarkably since the 1960's; while the population in Outer Tokyo has rapidly increased since 1960. Inner Tokyo is accordingly regarded as an area which had been already urbanized in the 1960's, thereby it corresponds to TANABE's old zone and new zone. Outer Tokyo is the area which has been incorporated into the Tokyo metropolitan area since about 1960, and this area corresponds to TANABE's extended area. Consequently, 154 municipalities are simplified into the two concentric areas.

Next step is the calculation of a residential location quotient (YAMAMOTO, 1980) to illustrate the spatial pattern and the degree of segregation by age group at the level of Inner Tokyo and Outer Tokyo. For the 14 age groups and for the six data-years residential location quotients of Inner Tokyo⁵⁾ are calculated as follows:

$$\text{Residential Location Quotient (RLQ)} = \frac{a/b}{A/B} \times 100$$

a: Population of age group A in Inner Tokyo

A: The total population of age group A in the Tokyo metropolitan area

b: The total population in Inner Tokyo

B: The total population in the Tokyo metropolitan area

The results are shown in Tab. 1, into which the content of 84 segregation maps is simplified with this procedure. When the residential location quotient (RLQ) of Inner Tokyo is more than 100, that age group is distributed more densely in Inner Tokyo in relation to the total population in that year. On the other hand, when the RLQ is less than 100, that age group is distributed more densely in Outer Tokyo. Moreover, the difference between the value of RLQ and 100 indicates the degree of segregation. For example, the RLQ of the 15–19 age group, which corresponds to the age group shown in Fig. 2, in 1975, is 106, and the RLQ of the same age group in 1985 corresponding to Fig. 3 is 95.

Tab. 1 can also be seen from the viewpoint of a cohort (Fig. 5). Cohort means in this paper a group, members of which were born in the same period. Members of the 1956–1960 cohort were, for example, born in the period between 1956 and 1960; this cohort, became 0–4 years old in 1960, 5–9 in 1965, 10–14 in 1970 and 15–19 in 1975; hence this cohort corresponds to the age group in Fig. 2. Fig. 5 is drawn from this point of view. The RLQs of 1956–1960 in 1960, 1965,

Table 1. Residential location quotients of Inner Tokyo

Age groups	1960	1965	1970	1975	1980	1985
0–4	95	94	90	87	89	93
5–9	91	92	92	88	85	86
10–14	94	92	95	94	89	86
15–19	107	104	104	106	102	95
20–24	110	110	112	116	118	114
25–29	105	104	102	104	108	112
30–34	99	98	95	94	98	102
35–39	99	97	96	93	93	96
40–44	98	99	99	98	95	93
45–49	98	100	103	102	101	96
50–54	98	100	103	107	105	103
55–59	98	100	103	108	110	107
60–64	96	100	104	108	111	110
65–	91	97	104	111	113	113

Figure 5. Residential location quotients of Inner Tokyo
—from the viewpoint of cohort—

Source: *Population Census of Japan 1960–1985*

1970 and 1975 are 95, 92, 95 and 106, as shown in Tab. 1, and the RLQ line of 1956–60 cohort in Fig. 5 links these RLQ values.

The next two sections will discuss some aspects of residential segregation in Inner Tokyo and Outer Tokyo observed in Tab. 1 and Fig. 5.

3. Principal characteristics of segregation pattern

The principal characteristics of segregation patterns in the Tokyo metropolitan area from Tab. 1 are as follows; first, 14 5-year age groups can be combined into four larger groups (0–14, 15–29, 30–44, 45 and over); second, each group has its own spatial tendency to segregate. The 0–14 age group and the 30–44 age group are distributed more densely in Outer Tokyo, while the 15–29 age group and the 45 and over age group are distributed more densely in Inner Tokyo; third, each tendency is almost constant throughout the study period⁶.

It can be observed in Fig. 5, from the viewpoint of the cohorts, that these RLQ lines change their slopes drastically three times at the ages of 5–9, 20–24 and 35–39, that is, these lines have three limit values. Thus, each cohort can be estimated to experience three turning points in its segregation pattern in the course of its life cycle, and its life cycle course is divided into four phases by these three turning points (see Fig. 5). In the first phase the lines fall to their minimum value

at the age of 5–9, that is, a cohort accelerates its degree of segregation in Outer Tokyo during this phase. In the second phase the lines turn up to their maximum value at the age of 20–24, and a cohort shifts its segregation pattern from Outer Tokyo to Inner Tokyo. The lines decline again to their other minimum value at the age of 35–39 in the third phase, and a cohort shifts its segregation pattern from Inner Tokyo to Outer Tokyo. In the last phase lines turn up again and a cohort slowly shifts its segregation pattern again from Outer Tokyo to Inner Tokyo.

4. Recent changes in segregation

Three changes of segregation pattern are found between 1980 and 1985 in Table 1. The 15–19 age group and the 45–49 age group shifted their segregation patterns from Inner Tokyo to Outer Tokyo, and the 30–34 age group shifted from Outer Tokyo to Inner Tokyo. These phenomena are not drastic change, but continuous modification as shown in Fig. 5, and one notices that this modification is concerned with the two following findings: first, the three limit values were very far from 100 in 1975 and 1980, and they get nearer to 100 after 1980; second, the inclination of some of the lines in Fig. 5 has got smaller in recent years.

If migration plays an important role in shaping residential segregation patterns, this modification can be supposed to be related to changes

of migration. This point will be further investigated.

III. MIGRATION AND SEGREGATION PATTERN

1. Migration and its effect on segregation pattern

According to previous studies (WATANABE, 1978; YANO, 1989), two main migration flows are recognized concerned with the Tokyo metropolitan area. The first flow is from out of the metropolitan area into the metropolitan area, and this flow consists mainly of in-migrants in

the latter half of their teens. The second flow is from central Tokyo to the suburbs, and most of the migrants of this flow are children aged between 0–14 and their parents. Moreover, KAWABE (1984, 1985) asserts that the principal characteristics of the first flow have not changed in the last several decades.

I verify these two migration flows and their consistency in Fig. 6 and Fig. 7. Here only the net migration is taken up, because that is the most important when the effect of migration is investigated. Fig. 6 shows the net migration rate by age group⁷⁾ from the Tokyo metropolitan area to other areas in the 1-year periods 1969–1970 and 1979–1980, and one notices that excessive in-migration is concentrated between 15 and 24 years old, and the net migration rates of the other age groups are close to 0. While, Fig. 7 shows the net migration rate by age group from the ward area of Tokyo to the rest of Tokyo and the adjoining three prefectures (Saitama, Chiba, Kanagawa). The ward area substitutes for Inner Tokyo, and the area which includes the rest of Tokyo and the three adjoining prefectures is the substitute for Outer Tokyo⁸⁾. The ward area has a deficit population in all of the age groups in the period 1969–1970. It has a slight surplus population only in the two age groups 15–19 and 20–24 in the period 1979–1980. In both periods the net migration rates of the 0–4, 5–9, 25–29 and 30–34 age groups are relatively high. Moreover, the net migration rate of each age group becomes lower in the period 1979–1980 than ten years before, but the basic characteristics of the net migration pattern do not change in the decade. These two figures have confirmed the existence of two migration flows as mentioned above, and the author would like to call them Young Flow and Family Flow.

Here I relate these two net migration flows with the four phases in Fig. 5. Young Flow has effects especially on the second phase and raises the RLQs of Inner Tokyo, because this flow carries the young population in their late teens and early twenties mainly into Inner Tokyo. Family Flow has effects on the first and the third phases and lowers the RLQs of Inner Tokyo. At the same time it affects the beginning of the second phase and raises the RLQs

Figure 6. Net migration rate of the Tokyo metropolitan area to the other area

Source: *Population Census of Japan 1970, 1980*

Figure 7. Net migration rate of the ward area to the surrounding area

Source: *Population Census of Japan 1970, 1980*

of the corresponding age groups in Inner Tokyo (see Fig. 5), though Fig. 7 shows a deficit of population of the age group 5–14 and 35 and over in Inner Tokyo. This kind of indirect effect of migration was pointed out by ISHIMIZU (1981) and KAGAWA (1987). ISHIMIZU investigates the aging phenomena in the three largest metropolitan areas in Japan, and asserts that the ratio of elderly (65 years old and over) in inner cities rises because the out-migration rate of the elderly from the central city to the suburbs is lower than that of the non-elderly population. In this study his suggestion is applicable not only to the elderly population but also to the middle-aged population 35 years old and over. Thus, the difference of out-migration rates between the age groups 0–4, 25–34 and the age groups 5–14, 35 and over, is considered to cause the rising RLQs of the latter age groups in Inner Tokyo.

2. Segregation pattern change of the 15–19 age group and migration: Cohort analysis

In the previous section it was confirmed that the principal characteristics of segregation pattern of Tokyo metropolitan area are affected by the two main migration flows. In this section I discuss particularly the recent segregation change of the 15–19 age group (see Figs. 2, 3, 5; Tab. 1) with an applied cohort analysis, to illustrate how the two migration flows affect the segregation pattern change.

1) Method

The population of the 15–19 age group in the Tokyo metropolitan area can be classified into two groups: those who were born and brought up in the Tokyo metropolitan area, and those who immigrated from out of the metropolitan area. The author estimated the numbers and the distributions of a part population of the two groups (the part shadowed or dotted in Fig. 8) with an applied cohort analysis. I would like to call the part population of the first group “the Native Young” and that of the second group “the Foreign Young”. This estimation is based on the following four assumptions:

(A1) The Foreign Young immigrate into the Tokyo metropolitan area only immediately after their graduation from junior high school or from senior high school⁹⁾.

(A2) Only these two types of in-migration con-

Figure 8. Method of estimation at metropolitan level

P_t : Population of the 15–19 age group in the year t

P'_{t-5} : Population of the 10–14 age group in the year $t-5$

N_t : Population of the Native Young in the year t

F_t : Population of the Foreign Young in the year t

$F1_t$: The Foreign Young who immigrated after the graduation from junior high school

$F2_t$: The Foreign Young who immigrated after the graduation from senior high school

M_t : Net migration population of the 15–19 age group in the period between $t-1$ and t year

tribute to the surplus population which a 5-year cohort gets in the 5-year period from 10–14 to 15–19.

(A3) Each 1-year portion of the Native Young has the same quantity of population in each 5-year cohort.

(A4) The Foreign Young immigrate constantly every year in each 5-year cohort, both after graduation from junior high school and after graduation from senior high school.

First, I estimated the numbers of the Native Young and the Foreign Young. The analytical unit here is the Tokyo metropolitan area. The method for estimation of N_t and F_t is as follows (see Fig. 8):

(1) Calculate N_t ; $N_t = P'_{t-5} \times 0.2$

(2) Estimate F_{1970} and F_{1980} ; only in 1970 and 1980 we can get the number of the last 1-year¹⁰⁾ net migration of 15–19 (M_{1970} , M_{1980}) from Population Census. $F_{1970} = M_{1970}$ and $F_{1980} = M_{1980}$ because $F'_t = F_t$ in Assumption (A4).

(3) Calculate $F_{1970}/F_{2_{1970}}$ and $F_{1980}/F_{2_{1980}}$ from P_t , P'_{t-5} and F_t ; then $F_{1970}/F_{2_{1970}} = 0.19$, $F_{1980}/F_{2_{1980}} = 0.02$

(4) Estimate F_t/F_{2_t} ($t = 1965, 1975$ and 1985); according to KAWABE (1984), the rate F_t/F_{2_t} is considered to continue falling till 1980, and then to be stable after 1980. Hence, the author estimated $F_{1965}/F_{2_{1965}} = 0.3$, $F_{1975}/F_{2_{1975}} = 0.1$ and $F_{1985}/F_{2_{1985}} = 0.02$

(5) Calculate F_t ($t = 1965, 1975$ and 1985) from F_t/F_{2_t} and $P_t - P'_{t-5}$

Second, I estimated the distributions of the Native Young and of the Foreign Young. This estimation must be done at municipality level; then one must consider intra-metropolitan migration. That is because some municipalities in the suburbs can increase their 15–19 population not only by in-migration of the Foreign Young, but also by in-migration of those who move with their parents from the central area of Tokyo to the municipalities in the suburbs. They are not regarded as Foreign Young but as Native Young. Thereby, the second assumption mentioned above must be altered and a fifth assumption is added as follows:

(A2)' The surplus or deficit population which a 5-year cohort gets in the 5-year period from 10–14 to 15–19 is attributed to two types; Foreign Young in-migration and Native Young migration with their parents.

(A5) The amount of the net intra-metropolitan migration of the Native Young in each municipality is equivalent to that of their parents' cohort¹¹⁾, that is, each of the Native Young is supposed to move with one of their parents.

The estimation process here is not the same as with the (1)–(5) procedure mentioned above, and this procedure is done for all municipalities in the Tokyo metropolitan area.

(1) Calculate N_t ; $N_t = (P'_{t-5} + PP_t - PP'_{t-5}) \times 0.2$

PP_t Population of the 45–49 age group in the year t

PP'_{t-5} : Population of the 40–44 age group in the year $t-5$

(2) Use the values F_t/F_{2_t} in the results of the former estimation procedure, then $F_{1965}/F_{2_{1965}} = 0.3$, $F_{1970}/F_{2_{1970}} = 0.19$, $F_{1975}/F_{2_{1975}} = 0.1$, $F_{1980}/F_{2_{1980}} = F_{1985}/F_{2_{1985}} = 0.02$

(3) Calculate F_t from F_t/F_{2_t} , P_t , P'_{t-5} , PP_t and PP'_{t-5}

(4) Map the results; the spatial distribution of the ratios of the Native Young and of the Foreign Young to each municipality's total population.

2) Results and Discussion

This examination yielded the results shown in Fig. 9, Fig. 10, Fig. 11, Fig. 12 and Fig. 13. Fig. 9 illustrates the changing numbers of the Native Young and the Foreign Young population in the Tokyo metropolitan area between 1965 and 1985, and it is recognized that the ratio of the Foreign Young has conspicuously fallen for the study period. This fall has been caused not only by the decrease of the Foreign Young, but also by the increase of the Native Young. The Foreign Young have decreased their number since 1965, that is, since the 1946–1950 cohort, while the increase of the Native Young began suddenly in the period 1975–1980, that is, between the 1956–1960 cohort and the 1961–1965 cohort. The Native Young populations of the 1961–1965 cohort and the 1966–1970 cohort are more than that of the 1946–1950 cohort, which includes the “baby boom generation” after the Second World War. From the 1950's in-migration into the Tokyo metropolitan area was accelerated, and the cohorts after 1961–1965 correspond to the children of these immigrants.

The four maps (from Fig. 10 to Fig. 13) show the distribution pattern of the Native Young and that of Foreign Young in 1975 (1956–1960 cohort) and 1985 (1966–1970 cohort) respectively. The Foreign Young are concentrated in Inner Tokyo in 1975 and 1985 as shown in Fig. 10 and Fig. 12, while the Native Young in 1975 are distributed equally in the metropolitan area except in the northeastern peripheral area¹²⁾ (see Fig. 11), and the Native Young in 1985 are distributed more densely in Outer Tokyo (see Fig. 13).

The author discusses now the recent change in segregation pattern of the 15–19 age group between 1980 and 1985, taking these results of this estimation into consideration. Comparing the 1956–1960 cohort with the 1966–1970 cohort

Figure 9. The estimated population of the Native Young and the Foreign Young in the Tokyo metropolitan area

Source: *Population Census of Japan 1960-1985*

Figure 10. Segregation pattern of the Foreign Young (1975)

1: over $\bar{x} + \sqrt{v}$
 2: $\bar{x}$ to $\bar{x} + \sqrt{v}$
 3: $\bar{x} - \sqrt{v}$ to $\bar{x}$
 4: under $\bar{x} - \sqrt{v}$
 $\bar{x}$ (mean) = 0.53%; $\sqrt{v}$ (standard deviation) = 0.53
 Source: *Population Census of Japan 1970, 1975*

Figure 11. Segregation pattern of the Native Young (1975)

1: over $\bar{x} + \sqrt{v}$
 2: $\bar{x}$ to $\bar{x} + \sqrt{v}$
 3: $\bar{x} - \sqrt{v}$ to $\bar{x}$
 4: under $\bar{x} - \sqrt{v}$
 $\bar{x}$ (mean) = 0.38%; $\sqrt{v}$ (standard deviation) = 0.38
 Source: *Population Census of Japan 1970, 1975*

Figure 12. Segregation pattern of the Foreign Young (1985)

1: over $\bar{x} + \sqrt{v}$
 2: $\bar{x}$ to $\bar{x} + \sqrt{v}$
 3: $\bar{x} - \sqrt{v}$ to $\bar{x}$
 4: under $\bar{x} - \sqrt{v}$
 $\bar{x}$ (mean) = 1.09%; $\sqrt{v}$ (standard deviation) = 0.19
 Source: *Population Census of Japan 1980, 1985*

Figure 13. Segregation pattern of the Native Young (1985)

1: over $\bar{x} + \sqrt{v}$
 2: $\bar{x}$ to $\bar{x} + \sqrt{v}$
 3: $\bar{x} - \sqrt{v}$ to $\bar{x}$
 4: under $\bar{x} - \sqrt{v}$
 $\bar{x}$ (mean) = 1.51%; $\sqrt{v}$ (standard deviation) = 0.21
 Source: *Population Census of Japan 1980, 1985*

in Tab. 1, the RLQs of the two cohorts at the age of 10–14 are 95 and 89, and those at the age of 15–19 are 106 and 95. As mentioned in Chapter II, the limit RLQ value of the 5–9 age group and the inclination of the RLQ line between 5–9 and 15–19 are supposed to be attributed to this change.

The ratio of the Foreign Young to all the young population, that is to say, the impact of Young Flow, is related to the line inclination between 10–14 and 15–19. The ratio of the Foreign Young population of the 1956–1960 cohort is 44.6%, while that of the 1966–1970 cohort is only 24.7% as shown in Fig. 8. The 1956–1960 cohort adds accordingly 11 points to its RLQ of 10–14, but the 1966–1970 cohort adds only 6 points.

The Native Young residential pattern derives directly from the residential segregation pattern of the corresponding 5–9 age group, and the degree of segregation is shown by the minimum limit RLQ value at the age of 5–9. Moreover, the residential segregation patterns of the 5–9 age group relate strongly to those of their par-

ents' generation, and Family Flow plays an important role in shaping these patterns. The segregation pattern of the Native Young of the 1966–1970 cohort reflects their parents' out-migration to the suburbs. Thus, the segregation patterns of the Native Young depend highly on the Family Flow which occurred one or two decades before.

Consequently, the change of the segregation pattern of the 15–19 age group between 1980 and 1985 is explained by two factors. First, the change of the ratio between the Native Young and the Foreign Young; second, the change of the residential pattern of the Native Young, which derives from Family Flow of their parents with them. Thereby, not only the Young Flow, but also the previous Family Flow have an effect on the change of the residential segregation of the 15–19 age group. Furthermore, the recent fall of the two net migration rates, which leads the three RLQ limit values nearer to 100, appears likely to reduce the degree of segregation by age group in the next decades at the level of Inner Tokyo and Outer Tokyo.

IV. CONCLUSION

This paper aims to describe the segregation patterns by age group and their recent change in the Tokyo metropolitan area, and then to try to explain the effects of migration on the segregation pattern.

The age groups of 0–14 and 30–44 tend to be distributed more densely in Outer Tokyo than in Inner Tokyo, and the age groups of 15–29 and 45 and over tend to be distributed more densely in Inner Tokyo. The two conspicuous migration flows, Young Flow from out of the metropolitan area to Inner Tokyo, and Family Flow from Inner Tokyo to Outer Tokyo, are observed and they create and alter these segregation patterns.

The investigation from the viewpoint of cohort of the recent change in segregation pattern of the 15–19 age group shows that this change is affected by the past Family Flow as well as by the present Young Flow, moreover that the increasing Native Young in Outer Tokyo play a more important role than the decreasing Foreign Young who immigrate into the metropolitan area in altering the segregation pattern.

The Native Young in Outer Tokyo are the children of those who moved to the suburbs 10 or 20 years ago, and now the suburbs are not an area where only young families live, but an area where many young people live. Some of them come up to the life stage of marriage and alteration of generations. Hence, I would like to point out the maturity of the suburbs after 1980. As mentioned in Chapter III, the degree of the segregation by age group will probably become smaller in a few decades, for which the maturing suburbs play an important role. In the 1960's and 1970's the Tokyo metropolitan area experienced population suburbanization, and most of the movers were young families, thus concentric age segregation patterns were created during this period. The factorial ecological studies pointed out the importance of family status at that time. However, as the suburbs mature, the importance of family status for residential differentiation in the Tokyo metropolitan area will probably decline.

The most important subject for future research

is on the trends of Family Flow in consideration of the different situations of the Native Young and of the Foreign Young. In the next decades most of those who correspond to the age of Family Flow will probably be the present Native Young, who have the chance to succeed to their parents' house, while it is hardly possible for the Foreign Young to get a house recently in Tokyo because of the recent extraordinarily high land prices. This difference will be very important for maintaining and changing the future residential structure of the Tokyo metropolitan area. Thus, a study on the alteration of generations in Tokyo is highly socio-economical.

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Notes

- 1) For example, Hiroshima and Fukuoka (MORIKAWA, 1976), Sapporo (YAMAGUCHI, 1976) and Tokyo (Nihon Jutaku Sogo Center, 1983)
- 2) The surrounding area consists of those municipalities which satisfy the following two conditions: i) The number of resident workers commuting to the central city is 10% or more of its total resident workers, and ii) the area is contiguous to the central city or to one municipality defined as a surrounding municipality. In case a municipality where under 10% of the resident workers commute to the central city is entirely enclosed by areas defined as surrounding municipalities, it is also regarded as a surrounding municipality.
- 3) A Population Census is held on October 1 every five years.
- 4) I employed the classification of the Population Census of Japan. The center of the circles is the Tokyo Metropolitan Government Office.
- 5) Here only two areas, Inner Tokyo and Outer Tokyo, are in question, thus it is sufficient to show only the results of Inner Tokyo. The results of Outer Tokyo are just the reverse of those of Inner Tokyo.
- 6) This does not apply to the residential patterns of aged residents in 1960 and 1965. That is because the peripheral area had not been urbanized in the 1960's, and the out-migration of the young population caused a shortage of that generation. Therefore, the ratio of the aged population to the total population in Outer Tokyo at that time was high in relation to the ratio in Inner Tokyo.
- 7) The age groups discussed here are not subdivided into 14 groups as mentioned before, but only into 11 groups (0–4, 5–9, 10–14, 15–19, 20–24, 25–29, 30–34, 35–44, 45–54, 55–64, 65–), due to the insufficiency of migration data.
- 8) For the same reason as note 7), the author was ob-

liged to use other analytical units. The area which includes Tokyo, Saitama, Chiba and Kanagawa is rather larger than the Tokyo metropolitan area.

- 9) Graduation from Japanese schools is at the end of March every year, and Population Census is held at the beginning of October as mentioned in Note 3). Thus, the part population discussed here is the population in the last half of 18 years old, who were born between October and the next March, and in the first half of 19 years old, who were born between April and September.
- 10) For example, in the 1980 Census migrations between 1st October 1979 and 30th September 1980 are reported.
- 11) Measuring the similarity of 84 segregation pattern maps by correlation coefficient, the age group of 40–44 is regarded as the parent generation of the age group of 10–14, and the 45–49 age group is regarded as that of the 15–19 age group.
- 12) That area had not been entirely urbanized in 1975. Areas which have not been urbanized in the metropolitan area tend to show a relatively high ratio of the 10–19 age group and the 40 and over age group in comparison with the other area because neither the Young Flow nor the Family Flow comes into this kind of area.

References

- BASSETT, K. and SHORT, J.R. (1980): *Housing and residential structure*, Routledge and Kegan Paul, London, 254 p.
- CLARK, W.A.V. (1981): *Residential mobility and behavioral geography: parallelism or interdependence?*. In *Behavioral problems in geography revisited*. Methuen, New York, 290 p.
- ISHIMIZU, T. (1981): Aging process in metropolitan areas, in *Asu no daitoshi 19: Daitoshi to daitoshiken mondai* (Metropolis in future 19: Metropolis and metropolitan area), Chuo Hoki, 142–159. (J)
- JOHNSTON, R.J. et al. (1986): *The dictionary of human geography*; second edition, Blackwell, Oxford, 575 p.
- KAGAWA, T. (1987): The areal distribution of aging phenomenon in the city: for each of the central cities in the six prefectures of Tohoku Region, *The Human Geography*, **39**, 370–384. (JE)
- KAWABE, H. (1984): The migration by age in the metropolitan area: The Cases of teenagers' migration in Tokyo metropolitan area, *The Journal of Population Problems*, **172**, 63–66. (J)
- KAWABE, H. (1985): Some characteristics of internal migration observed from the cohort-by-cohort analysis, *The Journal of Population Problems*, **175**, 1–15. (JE)
- KNOX, P. (1982): *Urban social geography*, Longman, London, 243 p.
- MAHER, C.A. (1982): Population turnover and spatial change in Melbourne, Australia, *Urban Geography*, **3**–3, 240–257.
- MORIKAWA, H. (1976): A comparative study of factorial ecologies in Hiroshima and Fukuoka, *Geographical Review of Japan*, **49**, 300–313. (JE)
- Nihon Jutaku Sogo Center (1983): *Tokyo Daitoshiken no chiikikozo no henka ni kansuru chosakenkyu* (Studies on the changing regional structure of metropolitan Tokyo), Nihon Jutaku Sogo Center, Tokyo, 114 p. (J)
- QUIGLEY, J.M. and WEINBURG, D.H. (1977): Intra-urban residential mobility: a review and synthesis, *International Regional Science Review*, **2**, 41–46.
- SHORT, J.R. (1978): Residential mobility, *Progress in Human Geography*, **2**–1, 419–447.
- TANABE, H. (1988): Divided urban core of Tokyo from the viewpoint of daily migration, *The Proceedings of the Department of Humanities, College of Arts and Sciences, University of Tokyo*, Vol. **88**, Series of Human Geography, **10**, 49–69.
- WATANABE, Y. (1978): Dwelling in Tokyo metropolitan area and intra-metropolitan migration, *Sogo Toshi Kenkyu*, **4**, 11–35. (J)
- YAMAGUCHI, T. (1976): The social areas of Sapporo — a factorial ecology, *The Proceedings of the Department of Humanities, College of Arts and Sciences, University of Tokyo*, Vol. **62**, Series of Human Geography, **7**, 83–105. (JE)
- YAMAMOTO, K. (1980): Spatial segregation of the "Gastarbeiter population" in Munich, *The Human Geography*, **32**, 214–237. (JE)
- YANO, K. (1989): Age-disaggregated intra-metropolitan migration in Tokyo metropolitan area, *Geographical Review of Japan*, **62**, 269–288. (JE)

東京大都市圏における年齢別居住パターンの分析

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本研究は東京大都市圏における5歳毎の年齢別居住パターンの特徴とその近年の変化を記述し、それらを人口移動に関連づけて説明することを目的とした。分析手法として多変量解析を用いずコーホート分析を利用し、以下の諸点を明らかにした。

- 1) 5歳毎の14の年齢階級の居住パターンを1960年から1985年まで検討すると、大半が同心円的であり、一般に0～14歳と30～44歳は大都市圏内の外圏において相対的に高い構成比率を示し、15～29歳と45歳以上は内圏で構成比率が高くなる。1980年以降はこの傾向に多少変化が見られ、15～19歳と45～49歳はむしろ外圏で、30～34歳は内圏で高い構成比率を示すようになった。
- 2) 東京大都市圏をめぐる人口移動の主要な流れとして、大都市圏外から大都市圏の内圏への10歳代後半から20歳代前半の若者の移動と、大都市圏の内圏から外圏への20歳代後半から30歳代とその子供たちの家族の移動の

2つが見いだせた。これらの2つの人口移動が前述の基本的な年齢別居住パターンの傾向を形成している。

- 3) 応用的なコーホート分析の結果、東京大都市圏では近年、若者全体に占める圏内育ち者の構成比率が急速に上昇していることが明らかになった。その要因として、圏外からの若者の流入数の減少とともに、1950年代、60年代に東京大都市圏に大量に流入した人々の子供にあたる世代が1980年頃から10歳代後半に達し始めたことが挙げられる。圏内育ちの若者の近年の居住パターンは、彼らの親世代の郊外への移動を反映して、外圏で高い比率を示す。こうした郊外の成熟が1980年以降にみられる年齢別居住パターンの変化を引き起こしていると考えられ、年齢別のセグリゲーションは少なくとも東京大都市圏の内圏・外圏というレベルでは、今後弱まっていくと予想できる。

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